

Common Sense Inference



Let's distinguish between:

- Mathematical inference *about* common sense situations

Example: Formalize theory of behavior of liquids

- Inference *with* common sense knowledge

Not too much about this yet

What is (mathematical) inference?

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Set of axioms (true assertions about the world)

Inference engine (set of IF-THEN inference rules)
that allows you to

Deduce new assertions from the old (forward
chaining)

Determine whether a given assertion is true
(backward chaining)

Classic example

Classic example



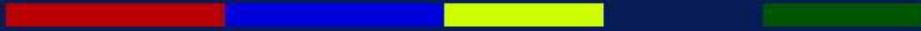
Birds can fly.

Tweety is a bird.

Therefore... Tweety can fly.

Not-so-classic example

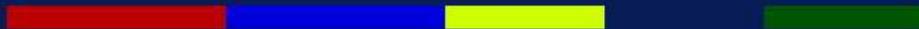
Not-so-classic example



Cheap apartments are rare.

Not-so-classic example

Not-so-classic example

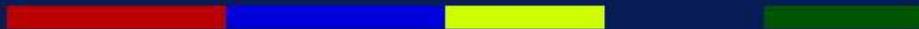


Cheap apartments are rare.

Rare things are expensive.

Not-so-classic example

Not-so-classic example



Cheap apartments are rare.

Rare things are expensive.

Therefore... Cheap apartments are expensive.

So, exactly what was wrong with that??

Common sense inference vs. Mathematical inference

Common sense inference vs. Mathematical inference



Mathematical inference =

Exact definitions

+ Universally true statements

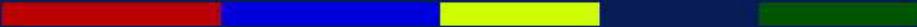
+ Complete reasoning

+ Depth-first exploration

+ Batch processing

Common sense inference vs. Mathematical inference

Common sense inference vs. Mathematical inference



Common sense inference =

- Imprecise definitions
 - + Contingent statements
 - + Incomplete reasoning
 - + Breadth-first exploration
 - + Incremental processing
-

Imprecise Definitions

Imprecise Definitions



Mathematical inference assumes airtight definitions

Common sense contains fluid definitions

Context-dependent

Fuzzy

Dynamic

Contingent statements

Contingent statements



All birds can fly, except

**Penguins, ostriches, dead birds, injured birds,
fictional birds, caged birds, ...**

Circumscription

It's true, unless you know otherwise

Non-monotonic reasoning

It used to be true that all birds can fly, but not now

Incomplete reasoning

Incomplete reasoning



Traditional logic looks for

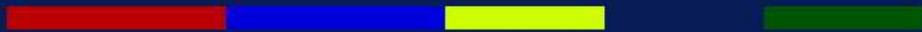
Consistency (can't prove a statement and its contradiction)

Completeness

Common sense inference is neither consistent nor complete

Incremental processing

Incremental processing



Most logical formalisms assume a “batch” process

You present assertions, queries, then system cranks

With common sense apps, you might learn stuff
while the system is inferring

The user might give you interactive feedback

Breadth-first exploration

Breadth-first exploration



Most logical inference (e.g. resolution theorem proving) is depth-first

Common sense is broad, not deep

What we want is that, if a simple answer exists, we will find it quickly

Best-first or most-relevant-first limits search

If logic is broken, let's fix it

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Non-monotonic logic and default logics

Circumscription, Situation Calculus

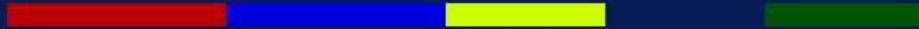
Formalization of Context

Fuzzy logic and probabilistic logics (e.g. Bayesian)

Multiple-valued logic (yes, no, maybe, dunno)

Modal logic (necessary, possible)

Example-based approaches



Go from specific to general rather than general to specific

Programming by Example

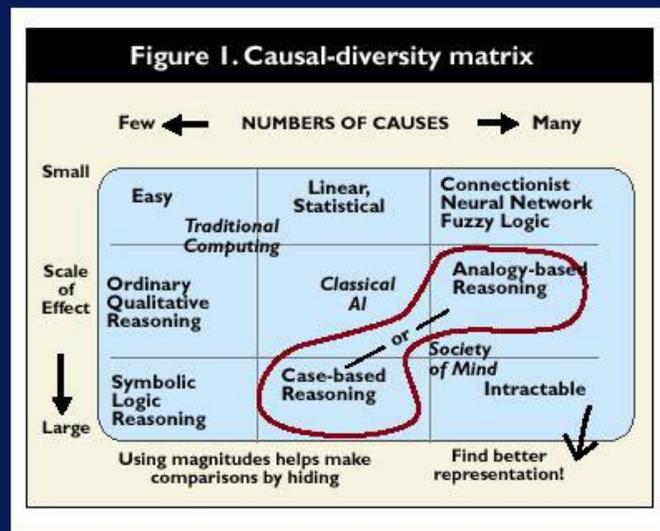
Case-Based Reasoning

Reasoning by Analogy

Abduction

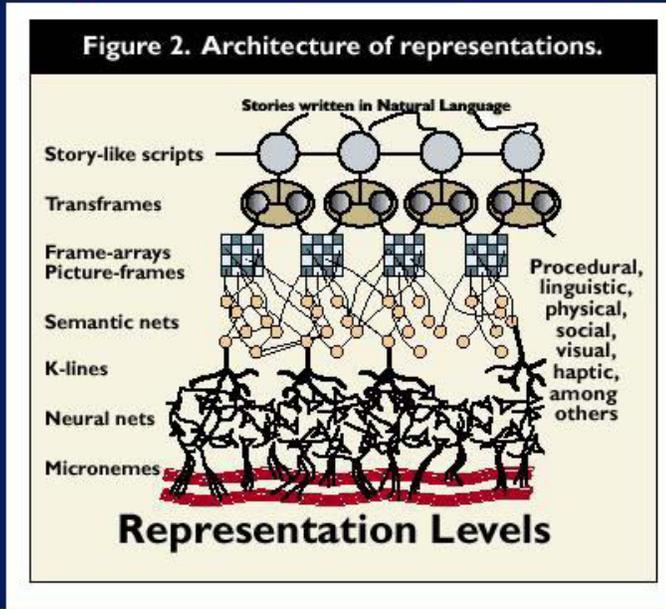
Causal Diversity

Causal Diversity



Maybe combine techniques?

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Common Sense vs. Statistical techniques



Some large-scale, IR, numerical and statistical techniques have achieved success recently

Will statistical techniques “run out”?

Not necessarily opposed to knowledge-based approaches

Could we use these techniques to “mine” Common Sense knowledge?

Implicit Inference



Do Aria, Empathy Buddy, Goose, etc. do Common Sense Inference?

Yeah, but maybe not explicitly

Use application context to perform limited inference



Common Sense and the Semantic Web



There's now a movement to make "The Semantic Web" -- turn the Web into the world's largest knowledge base

Could this be a vehicle for capturing or using Common Sense?

We've got to untangle the Semantic Web formalisms

Could this be a way to integrate disparate Common Sense architectures (to solve the software eng. problems of Minsky's proposals)?
